

REMARKS

Claims 1,3,7,9, 14-16 and 18-20, 22-30 are in the case. Reconsideration of the instant application is respectfully requested.

Claims

Applicants are somewhat confused because original examiner Maribel Medina Sanabria kindly stated in the original office action dated November 5, 2002, that original claims 2,4,6,8, 10 and 13 would be allowable if rewritten in independent form.

Applicants complied with these guidelines but are now faced with another office action. Applicants respectfully request that examiner reconsider the second office action and allow the application as amended in the Applicants' first amendment. In the case that such reconsideration is not granted Applicants have responded to the second office action below. Applicants' invention will be referred to as ("Applicants"-Application No. 09/842,818) while the prior art reference issued to same inventor will be referred to ("Mendelsohn"-U.S. Patent No. 5,900,042

Claim Objections

The examiner has objected to claims 11 and 21 as being in improper dependent form for failing to limit the subject matter of a previous claim under 37 CFR 1.75. Applicants have addressed this issue by deleting claims 11 and 21.

Claim Rejections under 35 U.S.C. § 102

The examiner has rejected claim 20 as anticipated or obvious over Bosch et al. Applicants submit that there is insufficient basis for regarding Applicants claims as anticipated or obvious over Bosch, as suggested by examiner. Applicants support their position by citing the substantial differences between Applicants' amended claims and those disclosed by Bosch.

Bosch et al., teaches a process for the absorption of nitrogen oxides by introducing a suspension of alkaline earth metal hydroxides and carbonates into a gas mixture in a state of fine division, for instance a spray or mist. Examiner is correct in pointing out that Bosch does not teach using a vaporized oxidizing agent. This is absolutely critical as vaporization is an essential element of Applicants' invention. Applicants specifically teach using only a vaporized oxidizing agent because it has been shown that vaporized agents are much more effective than liquid or atomized oxidizing agents in removing Hg and NO from gas streams. (See, Applicants' application as filed, page 4 lines 5-9, pg. 11 lines 19-25). Tables 4 and 5 of the original specification clearly illustrate the advantages of using a vaporized agent. (See, pgs. 11-122 of the original specification). Table 4 shows that vaporized agents remove more NO from the gas stream than the atomized agents even when the vaporized agents are 20 times lower in concentration than their atomized cousins. Table 5 illustrates that vaporization dramatically improves the ability of the oxidizing agent to remove Hg from the gas stream. The vaporized agents removed similar amounts of Hg from a gas stream with about a five-times lower concentration as compared to the use of atomized agents. The importance of vaporization to the present invention is also evident from applicant's abstract, specification and amended claims. See, pg. 3 lines 27-28, pg. 4 lines 5-10, pg 17, and claims 1,7,14 and 20 of the application. Furthermore, it would not have been obvious to use a vaporized oxidizing agent as stated by the Examiner. The present problem has existed for a long period of time and nobody has taught or suggested that using a vaporized oxidizing agent would dramatically increase the effectiveness of NO and Hg removal as taught by Applicants. Examiner states that "it is expected due to the high temperatures of nitrogen oxide containing flue gas" the liquid suspension would be vaporized. The examiner is again directed to tables 4 and 5 of the original specification

as well as lines 10-15 on pg. 10 which show that vaporized oxidizing agents vastly outperformed their atomized brethren even at temperatures of between 250-400°F (in which the tests were performed and) which correlated to the temperatures seen in flue gasses of power plants. Therefore, Applicants respectfully submit that an assumption that a atomized agent would vaporize due to the increased temperature of the flue gas and give the same result as an already vaporized agent would be a false assumption. In addition, Bosch does not teach or even disclose using its process for removing Hg. It is clear that claim 20 is not anticipated by or obvious in light of Bosch.

In addition, Bosch never discloses or suggests how to vaporize an oxidizing agent. The present invention teaches how to create a vaporized oxidizing agent from oxidizing solutions. See, pg. 5, lines 10-17 of the original specification. This vaporization step is especially important when the oxidizing agent is a solution at room temperature, such as chloric acid or a mixture of chloric acid and alkaline metal chlorate.

Claim Rejection under 35 U.S.C. § 103

The examiner has rejected claims 7,9, and 11 under 35 U.S.C. § 103 as being anticipated by Caldwell et al. Applicants submit that there is insufficient basis for regarding Applicant's claims as unpatentable over Caldwell, as suggested by examiner. Applicants support their position by citing the substantial differences between Applicants amended claims and those disclosed by Caldwell.

Caldwell et al., discloses a process for the removal of contaminants such as mercury, SO₂, NO, NO₂, and H₂S from flue gas streams. The Caldwell process comprises: contacting the flue gas stream with chlorine in a gaseous form, a liquid form, or as a chlorine water solution, at a temperature greater than 100°C and for a sufficient time to form an oxidized form of the contaminants. The oxidized stream is thereafter scrubbed with water, or water solution, of pH less than or equal to 7 and finally an alkali

metal iodine solution is added to precipitate mercuric iodide from the water or water solution.

In regard to previously amended claim 7 examiner suggests that "vaporizing an aqueous solution containing an oxidizing agent" or "vaporizing an oxidizing agent" would have been obvious to one of ordinary skill in the art in light of Caldwell. While the examiner is correct that Caldwell teaches the use of gaseous chlorine as an oxidizing agent, Caldwell also teaches the use of liquid chlorine and chlorine water solutions as oxidizing agents which is exactly what the applicant's teach to avoid. See, Caldwell, col. 3, lines 11-13, col. 1, lines 55-56. Applicants specifically teach using only a vaporized oxidizing agent because it has been shown that vaporized oxidizing agents are much more effective than liquid or atomized oxidizing agents in removing Hg and NO from gas streams. (see, page 4 lines 5-9, pg. 11 lines 19-25, of the original specification. Tables 4 and 5 of the original specification clearly show the advantages of using a vaporized oxidizing agent. (see pgs 11-12 of the original specification) Table 4 shows that vaporized agents remove more NO from the gas stream than the atomized agents even when the vaporized agents are 20 times lower in concentration than their atomized cousins. Table 5 illustrates that vaporization dramatically improves the ability of the oxidizing agent to remove Hg from the gas stream. The vaporized agents removed similar amounts of Hg from a gas stream with about a five-times lower concentration as compared to the use of atomized agents. The importance of vaporization to the present invention is evident from applicant's abstract, specification and amended claims. See, pg. 3 lines 27-28, pg. 4 lines 5-10, pg 17, and claims 1,7,14 and 20 of the original application.

In addition, Caldwell never discloses or suggests how to vaporize an oxidizing agent. The present invention teaches how to create a vaporized oxidizing agent from

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oxidizing solutions. See, page 5, line 10-17 of the original specification. This vaporization step is especially important when the oxidizing agent is a solution at room temperature, such as chloric acid or a mixture of chloric acid and alkali metal chlorate.

Furthermore, previously amended claim 7 has been amended to include the limitations of original claim 10 which are not disclosed by Caldwell as noted by the examiner on page 4, (paragraph 7) of the first office action. Applicants feel that previously amended claim 7 is in allowable form and is not obvious in light of Caldwell.

In addition, previously amended claim 7 sets a range of weight ratios. This range of weight ratios is important because it defines the optimal concentration range of the reactants and allows one to maximize efficiency by using only the amount of oxidizing agent necessary to accomplish oxidation saving both money and time. Nowhere does Caldwell suggest a range, ratio or weight percentages for the oxidizing agent. Examiner points out that Caldwell suggests that adding more oxidizing agent would increase oxidation however, nowhere does Caldwell disclose a set of ratios for increased efficiency. The mere fact that the prior art may be modified in a manner suggested by the examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. In re Fritch, 972 F. 2d 1260 at 1266 (1992). In fact, if such a modification was obvious, Caldwell could have easily included such specific additions in its disclosure, which it did not. Furthermore, Applicants argue that undue experimentation would be required to achieve such ratios. Applicants believe that the ratio disclosed in claim 7 is neither anticipated or obvious in the light of Caldwell as the disclosed weight ratio range is an improvement in the art in that it increases efficiency

Claim 9, which is dependent upon independent claim 7 is believed to distinguish over Caldwell for the same reasons as recited for claim 7 above.

Claim 11, which is also dependent upon independent claim 7 is believed to distinguish over Caldwell for the same reasons as recited for claim 7. In addition, claim 11 discloses that the presence of NOx enhances the capture of mercury using the present process. For support see, pg 5, lines 15-25 of the original specification. The examiner submits that Caldwell discloses that the presence NOx in the flue gas enhances the capture of mercury. While it is true that Caldwell teaches the conversion of metallic mercury to mercuric chloride in the presence of NOx, nowhere does Caldwell teach or even suggest that NOx in any way enhances the removal of metallic mercury from a flue gas using its process.

Examiner has rejected claims 1,3,8,14-16,18-19, 21-24 and 26-30 under 35 U.S.C. 103(a) as being unpatentable over Caldwell et al., in view of Mendelsohn et al. These claims are allowable for same reasons as cited above for claims 7, 9 and 11. As stated above Applicants method is novel is several aspects including its use of vaporized oxidizing agents as well as the specific oxidizing agents used by Applicants.

Mendelsohn teaches a method for the removal of mercury from a gas stream by reacting the gas with an oxidizing solution to convert the elemental mercury to a soluble form. The gas stream is then passed through a wet scrubber to remove mercuric compounds and oxidized constituents.

Moreover previously amended claim 14 teaches contacting a flue gas with an alkaline moiety after the oxidation process. See, original specification pg. 5, lines 3-5, pg. 5 line 30-pg. 5 line 2 and previously amended claim 14. Caldwell teaches away from the present invention by teaching scrubbing the flue gas with water or water solution of pH less than or equal to 7 which is exactly the opposite of what applicants teach. See, Caldwell col. 1 lines 61-67, col. 4 lines 19-25 and lines 35-40. Examiner states that it would have been obvious to combine Caldwell with the Mendelsohn to achieve a one-

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step removal of soluble compounds. Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. ACS Hospital systems, Inc. v. Montefiore Hospital, 732 F. 2d 1572 at 1577 (1984). Nowhere in Caldwell or Mendelsohn is it taught or even suggested that the two process be combined. Furthermore Mendelsohn teaches a process for the removal of mercury alone and not a combination of mercury and NO. For these reasons applicants submit that claim 14 distinguishes over Caldwell and is in allowable form.

Claims 16 and 19, which are dependent upon previously amended claim 14 are believed to distinguish over Caldwell for the same reasons as recited above for previously amended claim 14 above. Furthermore, claims 16 and 19 sets a range of weight ratios between the oxidizing agent and Hg. This range of weight ratios is important because it defines the optimal concentration range of the reactants and allows one to maximize efficiency by using only the amount of oxidizing agent necessary to accomplish oxidation saving both money and time. Nowhere does Caldwell suggest a range, ratio or weight percentages for the oxidizing agent. The mere fact that the prior art may be modified in a manner suggested by the examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. In re Fritch, 972 F. 2d 1260 at 1266 (1992). In fact, if such a modification was obvious, Caldwell could have easily included such specific additions in its disclosure, which it did not. Furthermore, Applicants argue that undue experimentation would be required to achieve such ratios. Applicants believe that the ratio disclosed in claims 16 and 19 are neither anticipated or obvious in the light of Caldwell as the disclosed weight ratio range is an improvement in the art in that it increases efficiency.

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Claim 18, which is dependent upon previously amended claim 14 is believed to distinguish over Caldwell for the same reasons as recited above for previously amended claim 14 above.

Examiner states that claims 1,8,15, 23-24, 26 and 30 are obvious in light of Caldwell's disclosure of using gaseous chlorine oxidizing agents and Mendelsohn's teaching of spraying a mist of a chloric acid with an alkali metal chlorate in order to obtain the desired gaseous form of the oxidizing agent. As stated above, obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

ACS Hospital systems, Inc. v. Montefiore Hospital, 732 F. 2d 1572 at 1577 (1984).

Nowhere in Caldwell or Mendelsohn is it taught or even suggested that the two process be combined. Furthermore, even if the Caldwell and Mendelsohn were combined they wouldn't disclose that which is taught by examiners. As stated above, neither reference vaporizes the oxidizing agent as taught by Applicants. (See arguments above about vaporization).

In relation to previously amended claim 15, the present invention is believed to distinguish over Caldwell for the same reasons as recited for claim 14 above. Furthermore, previously amended claim 15 teaches oxidizing agents not disclosed by Caldwell.

Previously added claim 20 is believed to distinguish over Caldwell because it incorporates all the limitations of original claims 6 and 13. Nowhere, does Caldwell teach or suggest using the disclosed compounds as the oxidizing agent. Applicants have followed previous examiner's instructions to rewrite claim 6 and 13 in independent form and submit that claim 20 is in allowable form.

Previously added claim 21, which is dependent on independent claim 1 is believed to distinguish over Caldwell for the same reasons set forth for claim 1 above. Additionally, previously claim 21 teaches that presence of SO_x improves Hg removal. Applicants unexpectedly discovered that the presence of SO_x actually improves Hg removal when the oxidizing agents disclosed in claim 1 (chloric acid, chloric acid and alkaline metal chlorate) are used. As applicants explain in the specification while sulfur dioxide typically has a detrimental effect upon oxidizing agents such as chlorine (taught by Caldwell) and bromine, the negative effects of sulfur dioxide are considerably less upon gaseous chloric acid or chlorine dioxide taught by the applicants. See pg. 10 lines 27-30 and pg. 11 table 2 of the original disclosure. This argument also applies to all the claims which teach the use of chlorine dioxide, chloric acid and alkaline metal chlorate or chloric acid as the oxidizing agent.

Previously added claim 22, which is dependent on independent claim 1 is believed to distinguish over Caldwell for the same reasons set forth for claim 1 above. Furthermore, previously added claim 22 discloses that the oxidizing agent converts NO to water soluble NO₂. See, pg 5 lines 5-7 of the applicant's original specification. In contrast, Caldwell neither teaches or suggests that its oxidizing agent converts NO to water soluble NO₂. In fact, when reacted with molecular chlorine (as taught by Caldwell) NO does not readily convert to water soluble NO₂. This distinction is important because NO₂ is water soluble and NO is not. Therefore, NO₂ is much more easily removed from the gas stream using aqueous scrubbers. This argument also applies to all the claims which teach the use of chlorine dioxide, chloric acid and alkaline metal chlorate or chloric acid as the oxidizing agent.

Previously added claim 23, which is dependent on previously amended claim 7 is believed to distinguish over Caldwell for the same reasons set forth for previously

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amended claim 7 above. In addition, previously amended claim 7 distinguishes over Caldwell for the reasons explained for claim 1.

Previously added claim 24, which is dependent on previously amended claim 7 distinguishes over Caldwell for the same reasons set forth for claim 7 above. Furthermore, previously claim 24 discloses using oxidizing agents not taught or suggested by Caldwell. This distinction is important since Applicants have illustrated that using the oxidizing agents taught by Applicants is critical to the invention and are vastly superior to the oxidizing agents used in the prior art.

Previously added claim 25, which is dependent on previously amended claim 14 distinguishes over Caldwell for the same reasons set forth for previously amended claim 14 above. Furthermore, previously added claim 24 discloses using chlorine dioxide as the oxidizing which is not agent not taught or suggested by Caldwell. Examiner suggests that it would be obvious to use chlorine dioxide since Senjo et al., teaches a similar process. Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. ACS Hospital systems, Inc. v. Montefiore Hospital, 732 F. 2d 1572 at 1577 (1984). Nowhere in Caldwell or Senjo is it taught or even suggested that the two process be combined, furthermore Senjo teaches a process for the removal of sulfur oxides and/or nitrogen oxides and never discloses an ability to concurrently remove mercury as well.

Previously added claim 26, which is dependent on previously amended claim 14 distinguishes over Caldwell for the same reasons set forth for previously amended claim 14 above. Furthermore, previously claim 24 discloses using oxidizing agent not taught or suggested by Caldwell.

Previously added claim 27, which is dependent on previously amended claim 14 distinguishes over Caldwell for the same reasons set forth for previously amended claim 14 above. Previously added claim 27 also teaches the process of vaporization as passing an oxidizing solution through a heat exchanger in order create a vaporized oxidizing agent. See pg 6. of the original application. Previously added claim 27 also defines a preferred temperature range for vaporization.

Previously added claim 28, which is dependent on previously amended claim 14 distinguishes over Caldwell for the same reasons set forth for previously amended claim 14 above. Moreover, claim 28 teaches actively mixing the gaseous stream with the vaporized oxidizing agent by inserting the oxidizing agent in a counter current direction with respect to the flue gas. This distinction is important because actively mixing the oxidizing agent with the flue gas stream reduces the residence time required for oxidation, increasing efficiency. See, pg. 6 lines 26-29 of applicant's original disclosure. Caldwell neither teaches or even suggest injecting the oxidizing agent in a counter current direction. If it was obvious to inject the oxidizing agent in a counter current direction it would be expected that the prior art teach or at least suggest such an option which it has not.

Previously added claim 29, which is dependent on previously amended claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above.


Previously added claim 30, includes essentially all the limitations of original claim 2 which examiner notes are not disclosed by Caldwell. Caldwell fails to teach or even suggest using chloric acid, chlorine dioxide or chloric acid and an alkali metal chlorate as the oxidizing agent. It is believed that, claim 30, distinguishes over Caldwell.

It should be noted that many of the arguments presented for one claim, may be, and often are, applicable to other claims.

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Applicants' attorney has carefully reviewed the other references, cited by the Examiner but not applied. None of these cited references anticipated Applicants' invention as now claimed.

The Applicants believe that the application, including claims, 1,3,7,9,14-6, and 18-20, 22-30, is now in allowable form. Allowance is therefore respectfully requested

Respectfully submitted,
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COMPLETE LISTING OF CLAIMS, INCORPORATING AMENDMENTS
IN RESPONSE TO OFFICE ACTION DATED March 26, 2003
FOR SERIAL NO. 09/842,818

1. (Previously Amended) A process for removing elemental mercury from a gaseous stream comprising:

a) contacting a vaporized oxidizing agent with the gaseous stream for a time and at a temperature sufficient to form water soluble nitrogen and mercury-containing compounds, wherein the oxidizing agent comprises chloric acid and an alkaline metal chlorate; and

b) removing the water soluble compounds from the gas stream.

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[2. (Canceled)

2.
3.

(Original) The method as recited in claim 1 wherein the principal components in the gaseous stream are vaporized chemicals selected from the group consisting of mercury, nitrogen oxides, sulfur oxides, carbon oxides, hydrochloric acid, oxygen, nitrogen, water vapor, and combinations thereof.

[4-6 (Canceled)

4.
7.

(Previously Amended) A method for simultaneously removing elemental mercury and NO_x from a flue gas stream containing other constituents, the method comprising:

- g) vaporizing an aqueous solution containing an oxidizing agent, wherein the oxidizing agent is present in the aqueous solution at a concentration of between 0.001 and 5 weight percent; and
- h) contacting the vaporized oxidizing agent with the gaseous stream for a time and at a temperature sufficient to form water-soluble nitrogen- and mercury containing compounds; and
- i) removing the water-soluble compounds.

5.
8.

(Original) The method as recited in claim 1 wherein the oxidizing agent comprises chloric acid and an alkali metal chlorate.

6.
8.

(Original) The method as recited in claim ⁴7 wherein the components in the gaseous stream are selected from the group consisting of mercury, nitrogen oxides, carbon oxides, hydrochloric acid, oxygen, nitrogen, water vapor, and combinations thereof.

10. (Canceled)

11-13. (Canceled)

9.
14.

(Previously Amended) A method to simultaneously remove mercury and nitric oxide from flue gas, the method comprising:

- n) vaporizing an oxidizing agent;

- o) contacting the vaporized oxidizing agent with the flue gas for a time and at a temperature sufficient to create water soluble mercury and nitrogen-containing compounds; and
- c) removing the water soluble compounds from the gas stream, wherein the water soluble compounds are removed using aqueous scrubbers employing alkaline moieties.

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~~15~~ (Previously Amended) A method as recited in claim ⁹~~14~~ wherein the oxidizing agent contains halogen compounds selected from the group consisting of chloric acid, chlorine dioxide, sodium chlorate, sodium hypochlorite, bromic acid, iodic acid, and combinations thereof.

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~~16~~ (Original) The method as recited in claim ⁹~~14~~ wherein the oxidizing agent is present with the Hg in the flue gas in a weight ratio between approximately 100,000 : 1 to 1000 : 1 of oxidizing agent : Hg.

[¹⁷
~~18~~ (Canceled)

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~~18~~ (Original) The method as recited in claim ⁹~~14~~ wherein the flue gas contains sulfur oxides at concentrations up to 4,000 ppm.

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~~18~~ (Original) The method as recited in claim ⁹~~14~~ wherein the oxidizing agent is present with the flue gas in a weight ratio between approximately 1:500,000 and 1:100 of oxidizing agent : flue gas.

19.
~~20.~~

(Previously Added) A method to simultaneously remove mercury and nitric oxide from flue gas, the method comprising:

- a) contacting a vaporized oxidizing agent with the gaseous stream for a time and at a temperature sufficient to form water soluble nitrogen and mercury-containing compounds, wherein the oxidizing agent is selecting from the group consisting of an alkali metal hydroxide, and alkaline earth metal hydroxide, an alkali metal carbonate, an alkaline earth metal carbonate and mixtures thereof; and
- b) removing the water soluble compounds from the gas stream.

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[21.

(Canceled)

3.
~~22.~~

(Previously Added) A method as recited in amended claim 1, wherein the oxidizing agent converts NO to water soluble NO₂.

7.
~~23.~~

(Previously Added) A method as recited in amended claim ⁴~~7~~, wherein the oxidizing agent is selected from the group consisting of chloric acid, chlorine dioxide, and chloric acid and an alkali metal chlorate.

8.
~~24.~~

(Previously Added) A method as recited in amended claim ⁴~~7~~, wherein the oxidizing agent is selected from the group consisting of chloric acid, chlorine dioxide, sodium chlorate, sodium chlorite, sodium hypochlorite, bromic acid, iodic acid, and combinations thereof.

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~~25.~~ (Previously Added) A method as recited in amended claim ⁹~~14~~, wherein the oxidizing agent is chlorine dioxide.

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~~26.~~ (Previously Added) A method as recited in amended claim ⁹~~14~~, wherein the oxidizing agent is chloric acid.

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~~27.~~ (Previously Added) A method as recited in amended claim ⁹~~14~~, wherein vaporization of the oxidizing agent is accomplished by passing it through a heat exchanger, the heat exchanger being at a temperature between 400 and 500°F.

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~~28.~~ (Previously Added) A method as recited in amended claim ⁹~~14~~, wherein the vaporized oxidizing agent contacts that gaseous stream in a counter current direction.

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~~29.~~ (Previously Added) A method as recited in amended claim ⁹~~14~~, wherein the alkaline moieties are selected from the group consisting of NaOH, Mg(OH)₂, Ca(OH)₂, NaCO₃, K₂CO₃, MgCO₃, CaCO₃ and combinations thereof.

²⁰
~~30.~~ (Previously Added) A process for removing elemental mercury from a gaseous stream comprising:

- a) contacting a vaporized oxidizing agent with the gaseous stream for a time and a temperature sufficient to form water soluble nitrogen and mercury-containing compounds, wherein the

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conclude

oxidizing agent is selected from the group consisting of: chloric acid, chloric acid and an alkaline metal chlorate, chlorine dioxide or combinations thereof; and

- b) removing the water soluble compounds from the gas stream .
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